

blast. The cranial ganglia take their entire origin from Froriep's "Kiemenspaltenorganen." These structures were first discovered by Froriep, and independently by Beard, who identified them as the foundations of the lateral sense organs, and termed them, because of their genetic relations to the gill-clefts, the "branchial sense-organs." Moreover, as previously stated, these patches of sensory epithelium, the "placodes" of Kupffer, were shown to be the sources of ganglionic elements, forming the lateral ganglia. Goronowitsch has now, therefore, endeavoured to limit the cranial ganglia in their origin to these lateral sources alone.

Peculiar, though not confined to himself, are the views maintained by Dr. Goronowitsch as to the mode of attachment of the ganglion with the central organ, and as to the formation of nerve-fibre in general.

In the solutions offered of these problems—which, of course, are really one and the same, to wit, that of the development of nerve—he places himself entirely on the side of A. Sedgwick.

The latter zoologist has maintained, without thus far illustrating his thesis by figures, that nerve-fibres arise *in situ* in the mesodermic reticulum, connecting together the various portions of the developing embryo and filling all the spaces between skin and central nervous system.

The logical conclusion attaching to this view is that nerve is mesodermal in origin. This conclusion Goronowitsch does not hesitate to draw. In his own words in literal translation he says (*inter alia* on p. 40) "the nerve-forming tissue of the complex nerve-trunk is furnished by axial mesoderm."

Incidentally he, like Sedgwick, rejects the doctrines of His, Golgi and their followers, that nerve-fibres arise as processes of ganglion-cells. Naturally! The two views are mutually exclusive. If nerve-fibres arise in a reticulum of mesoderm or mesenchyme, they cannot also be processes of ganglion-cells.

Whatever is to be said for the full acceptance of the process-theory of His and Golgi, and whatever the ultimate fate of the germ-layer theory, no fact in vertebrate embryology stands on a firmer basis than the origin of all nervous structures from the outer layer, the ectoderm or skin, and to fall back upon the mesoderm or its reticulum as the source of nerve appears to us a retrograde step to the embryological standpoint of thirty years ago.

While readily and willingly acknowledging Goronowitsch's industry and zeal in working out this memoir, evidenced by the detailed and laborious description, the carefully drawn and beautifully lithographed plates, his main thesis must remain in abeyance until proof further and more convincing, that this is so for representative members of each of the great vertebrate classes, can be brought forward.

### THE UTILITY OF KNOWLEDGE-MAKING AS A MEANS OF LIBERAL TRAINING.<sup>1</sup>

THE subject on which I wish to address a few remarks to you to-day, by way of opening the fortieth session of our College, is the utility of knowledge-making as a means of liberal training.

That the main work of the highest of educational institutions should consist of original research, and that ability to make additions to knowledge should form the chief test of qualification for the highest academic distinction, may be said to have received world-wide recognition; but the value of research work in institutions or departments of a lower grade has not been similarly recognised, and the tests for lower academic degrees and certificates do not, in general, at least formally, include a research test. I wish to bring to your notice some considerations which go to show that the work of all educational institutions, from the highest to the lowest, should be, to a considerable extent, at least, of the nature of original research—understanding by that term, however, the effort to make additions to our own knowledge, not necessarily to the knowledge of the race.

In this sense we have all been engaged more or less in original research from our earliest years; and we probably attained greater success in infancy than in youth or in later life. The young child is completely cut off from all external sources of information; and it could acquire no knowledge beyond a remembrance of confused sensations, if it did not possess the

power of "putting that and that together" and finding things out for itself. By applying this power, however, the child succeeds in bringing a large measure of order out of the chaos of sensations which it experiences. The method which it uses is the scientific or knowledge-making method. It finds out the usage of a word, for example, by putting together various instances of its use, constructing a theory as to the meaning of the word, testing the theory by subsequent observation, and modifying the theory as experience widens—in fact, by subjecting its experience to imagination, induction and deduction, and thus, as the logicians would say, generalising such experience. How exactly the process is carried out, even the New Psychology has not yet told us. But it certainly gets carried out somehow; and the result is a series of brilliant, though possibly to some extent sub-conscious, discoveries. The evolutionist would tell us, perhaps, in his learned phraseology, that this phenomenon is a case of the ontogenetic recapitulation of phylogeny, by which he would mean that the young animal in learning its mother-tongue passes in a few months or years through an epitome of the course of development for which the race required as many æons. Even so, the phenomenon does not lose its suggestiveness from our present point of view.

Whether it be because, when the mother-tongue has been acquired, the period of ontogenetic recapitulation is complete, and the child brought thereby up to date, or because it is then brought into communication with encyclopædic friends, I cannot say; but certainly once the child is able to question its mysterious neighbours and to understand their answers, its power of applying the scientific method rapidly diminishes, becoming weakened apparently because of the readiness with which information may now be obtained by simple appeal to authority. But though weakened the power is not wholly lost; for it exhibits itself, more or less, in the study both of language and of natural phenomena, during the period of tutelage between early childhood and incipient manhood, and it comes into greater or smaller activity when the young man goes forth to engage in the work of life. And what his degree of success is to be in such work as his hand may find to do will depend, in no small measure, upon his power of putting that and that together and making knowledge for himself from his own experience.

The value of experience in the direction of the work of life does not need to be established by argument. It has become proverbial. But the connection of its value as a directing agency with the making of knowledge may need a few words of exposition. That the mental process which enables us to learn by experience in later life is a knowledge-making process—the same as that used by the child in acquiring its mother-tongue, though perhaps more consciously performed—becomes obvious if we consider any particular kind of work in which men engage. The merchant, to take a single case, in order that he may be able to foresee what kinds and qualities of the many articles in which he deals it will be desirable for him to have in stock, must watch the purchases of his customers, and make mental note of their satisfaction or discontent. The transactions are too numerous to be carried in the memory or to admit of written memoranda. If he is to make progress in judging as to what his stock should include, he must put related experiences together, weld the lessons he learns from them into general rules, and make these rules more and more accurate as time goes on. And the same is true of many other questions which he must settle for himself. Unless, in fact, he can generalise his mercantile experience, as a child generalises its linguistic experience, he must continue to buy and sell with no greater intelligence than he did at the outset of his business career.

"Till old experience do attain  
To something like prophetic strain,"

as Milton puts it, he can have no complete success.

A similar statement may be made with respect to the physician, the farmer, the investigator, the housewife, the artisan, the politician, the clerk,—with respect, in fact, to all classes of workers, whatever the form of work in which they may be engaged. It may be made also, not only in regard to their main work, but in so far as they may in addition be engaged in athletic, literary, artistic, political, social, religious, or any other effort, and whether that effort take the form of work or play. In short, it is applicable to a greater or smaller extent to at least the great bulk of the various forms of activity of which the lives of most of us are made up. The subject-matter of experience, the material with which we must deal, is different in different cases; but there is one condition

<sup>1</sup> Inaugural address delivered at the opening of the fortieth session of Dalhousie College, Halifax, Nova Scotia, on September 13, by Prof. J. G. Macgregor.

of success which is common to them all,—the possession of the power of foreseeing; and there is one method of acquiring foresight,—the making of knowledge for ourselves from our own experience.

If this be so, it is obvious that this power of knowledge-making should be raised to as high a pitch of efficiency as possible before we enter upon the active work of life. Its growth, like that of all intellectual faculties, is slow; and the facility of its initial cultivation diminishes with advancing years. It is hazardous, therefore, to postpone its cultivation until we are face to face with the problems of life, or even until we enter upon the special study of the main work of life in the technical or professional school. It should be cultivated, and cultivated with especial care, during the whole period of tutelage, whether it be spent at the school only or in part in a department of liberal training of the college. And in order that it may be cultivated, it must be kept in continual exercise.

I do not know that provision for the exercise of this faculty has ever been generally made, with full consciousness, in either school or college; but it can readily be shown that it was given far more exercise in the educational institutions of two or three generations ago, than it is in general in those of the present day.

The curriculum of the old schools, which is also that of the old-fashioned conservative school of our time, consisted largely of classics and mathematical science (including natural philosophy), its backbone being the study of classics; and while the study of mathematics, though an admirable discipline, is for the most part deductive in character, and thus gives only a limited exercise to the power under consideration, the study of language, and especially the study of Latin and Greek, gives it very abundant exercise. Even if the study of a language is carried out with the aid of a grammar and a lexicon, *i.e.* with frequent appeal to authority, it involves continual putting together of instances of the usage of words and phrases which have come to our notice, formation of hypotheses as to their usage, and repeated modification of such hypotheses, after they have been brought to the touchstone of experience. The lexicon, especially the lexicon of the old school, would give little more than a clue in many cases to the English equivalents of say, Latin words, the exact equivalents, whether words or phrases, being determinable only by a study of the context and a fruitful drawing upon experience. And when we think how large is the number of words and phrases and constructions, of the usage of which the student of a language is gradually forming more and more accurate conceptions, we see at once how abundant is the exercise which this study provides of the putting of that and that together. The material on which the knowledge-making power is thus exercised, is of course of one kind, and therefore in general of a kind quite different from the material on which it must be exercised in after life. The exercise afforded is thus one-sided and by no means complete. But it is nevertheless exercise of the same intellectual power which we must later on apply to the more varied and complex material which life will afford.

While the study of the classics gave the student under the old régime considerable experience in the making of knowledge, the curriculum as a whole gave him both the key to his own literature and the literatures of Greece and Rome, and an introduction to the principles of the systems of knowledge which existed at the time. His stock of information we should now consider small; but it bore a great ratio to the whole body of available information. And it should be noted that such knowledge as the student had acquired, had been acquired in a leisurely, thoughtful way, and largely by his own effort, and would thus have become a permanent possession.

The men of the schools, therefore, in those days, had acquired, besides facility of access to the great storehouses of human wisdom, two things of direct importance for success in the work of life—an outfit of knowledge and the power of adding to it from their own experience. They were consequently men of power, and were recognised as such. And as it was the knowledge they possessed that was the only readily recognisable part of their outfit, their knowledge came naturally to be regarded as the secret of their power.

It appears to be Bacon to whom the credit belongs, of having coined the aphorism: "Knowledge is power." If so, to Bacon also must attach the opprobrium of having perpetuated a false and vicious generalisation. However important knowledge

may be, it is not *the* essential condition of power. It is only one of the conditions. A second, perhaps the first, is the ability to make knowledge, which *may* be developed in the acquisition of knowledge, but also may not. No knowledge, no power: would have been sound doctrine; Knowledge *is* power: was false doctrine.

And while the possession of knowledge is essential to power, it is not the possession of an outfit of knowledge at the beginning of active life that is essential, but the possession of such outfit when it is wanted. In the old days the world's whole stock of knowledge was so comparatively small, that it was possible in the period of tutelage to get an outfit of its principles at least. At the present day the world's stock is so large, that the school and college can no longer furnish a corresponding outfit. Yet the men of the present day are at little disadvantage on that account. For as the volume of knowledge has increased, its accessibility has increased also. And thus, provided the student of to-day has been trained to acquire knowledge, has been taught, in fact, the most important of the three R's, the art of reading, with all that the art of reading involves, he can readily provide himself at any time with such information as he may require. Thus, nowadays, it is not so much knowledge that is even one of the conditions of success, as a well developed power of acquiring knowledge.

It was largely on the basis of Bacon's false generalisation that the fight was waged in later years between classics and the rapidly growing sciences. The advocates of the introduction of science into the curriculum of the school and college, based their demand mainly on the importance for success in life and for general culture, of a knowledge of the laws of natural phenomena. And their opponents, though relying largely on the excellence of the results achieved under the old system, met the utilitarian arguments of men of science by urging various minor utilities involved in the study of Latin and Greek. Neither party seems to have realised, at least fully, the more profound utility which might be involved in both kinds of study.

The introduction of science into the curriculum under this mistaken conviction could not but have unfortunate results. Its primary effect on the study of classics was to diminish the time devoted to it. But there was a more serious secondary effect; for, since knowledge was power, and as much knowledge of Latin and Greek must therefore be acquired, if possible, as before, the student had to be subjected to a forcing process. Helps of all kinds consequently developed a vigorous, nay a rank, growth—elaborate grammars full of detailed information, lexicons giving all the shades of meaning that words might have, annotated texts removing all difficulties from the student's path, even translations, fitly described in college slang as *cribs* and *ponies*. Power of translating was acquired by the aid of such educationally illegitimate helps; but it was acquired to a smaller extent than formerly, by the student's generalising his own experience and to a greater extent by the use of information derived from authority. The study of the classics consequently, first because of the diminution of time, and secondly because the time was no longer so well employed, came to provide a doubly diminished exercise of the knowledge-making power. The command of the classical languages, too, which was thus acquired, became for these reasons a less permanent possession; and the study of them no longer served to open up to the student, to the extent to which it had previously, the great literatures of the past.

Nor did the science study itself atone for the deterioration which its introduction involved in the study of classics. I need hardly point out that the method which is used in the making of knowledge in any branch of science, is the same as the method we must apply in making knowledge from the experience of everyday life. Indeed, it gets the name of the scientific method, because, though it had been used by men in all ages in the learning of languages and in learning by experience of all kinds, it was first brought to the notice of logicians by the rapid development of science, which resulted from its systematic application to the study of natural phenomena. Any single science, therefore, may be studied as any language may, so as to afford practice in knowledge-making. Language study has the advantage of affording a larger number of simple problems on the material of which the student has the widest experience. A science has the advantage of presenting problems with a greater range of difficulty on a material which is in general more complex. A



group of sciences has the further advantage over even a group of languages, of affording a greater variety of subject-matter for the exercise of the knowledge-making power, and consequently giving the student practice in learning from experience under such different conditions as to fit him more completely for using his experience under the conditions of actual life.

The combination of linguistic and scientific study, therefore, if both had been conducted by knowledge making methods, might have been expected to produce better results in the cultivation of the knowledge-making power, than the study of either singly. But under the domination of the conviction that knowledge is power, science could not be studied in this way. The main object for which it had been introduced into the curriculum was the provision of an outfit of useful information, and the study must be carried on, so as to provide as large an outfit as possible. The obvious means of furnishing this outfit was the synoptic text-book; an epitome of the latest results in any branch of science; and all that the student had to do, in order to possess himself of it, was to get up the book. Clearly with this as his method he could not learn to use his own experience, but must become

"Deep versed in books and shallow in himself."

It is true, that when, after a time, the new science study was found to have become a mere getting up of books, the cry of "Back to nature!" was raised. As Wordsworth put it:

"Come forth into the light of things,  
Let Nature be your teacher."

As a result, experimental demonstrations were tried; but they were found insufficient. And now laboratory work has been introduced into school and college, and students are made, themselves, to carry out many scientific processes. They are taught to use the balance, to verify Boyle's law, to measure electric currents, to prepare gases, to analyse solutions, to dissect frogs, to classify insects, to use the microscope, to hunt out the names of plants. But they are always shown how to do the things required of them. And thus, from our present point of view, this mode of coming into the light of things can be of little avail. For while it makes the student's conceptions more vivid and the knowledge acquired more accurate and less transitory, and while it affords subsidiary training, *e.g.* of the hand and the eye, it gives but little additional opportunity of acquiring power in the making of knowledge. Even such additional opportunity as was at first afforded, when the student had no book to follow and was thrown to a certain extent upon his own resources, has now been withdrawn. For it was soon perceived that a greater amount of ground could be covered if he spent no time in working things out for himself. And so the text-book of laboratory work was devised, telling him exactly what to do and exactly how to do it. "Back to nature!" has thus meant: Back to books! And it could not have been otherwise. For under the conviction that it is knowledge that is power, practice in the putting of that and that together must appear to involve a waste of precious time.

There is another influence which has tended to strip the study of science of the high educational value which it might possess, *viz.*, the influence of the written examination. Men of knowledge under the old régime having been found to be men of power, it became desirable that they should be certified by competent bodies. The degree and the diploma thus came into prominence; and the tests applied to candidates for them, when the candidates became numerous, took generally the form of written examinations. Now it is quite possible to test in this way the possession of command over a language, of deductive power in such subjects as mathematics or philosophy, and of information on any subject. But it is impossible to test by examinations of this kind, directly, the possession of the knowledge-making power. The making of knowledge, even in its humbler forms, is a creative process. It occurs only when the flash of imagination lights up the storehouses of experience and reveals the relations of its accumulated observations. And as the wind bloweth where it listeth, so imagination does not become luminous at command. Put even such men as Faraday or Darwin into the examination hall and tell them to spend an hour in exhibiting on paper their ability to find things out for themselves, and they must almost inevitably fail. It would, in fact, be no more absurd to ask a poet to exhibit true poetic inspiration, at a given date, than to ask a knowledge-maker to make knowledge.

I, therefore, the possession of knowledge-making power is to be tested at all by written examinations, it must be tested indirectly. And in some cases it can. The exercise of this power in the study of a language, besides strengthening the power itself, produces a command of the language which is not otherwise attainable. And consequently it is possible to test the acquisition of this power in linguistic study, indirectly, by a skilful testing of the candidate's command of the language. Its exercise in science study, however, produces in addition to increase of the power itself, nothing but a stock of information, which is much more readily obtainable from books. The acquisition of the knowledge-making power in science study cannot therefore be even indirectly tested by the written examination.

Now written examinations, when used either as the only tests, or as the chief tests, for a degree or a certificate, must tend to encourage the acquisition of what they are capable of testing and to discourage the acquisition of what they cannot test. For candidates soon find out what kind of work will pay, and they naturally confine themselves to it. Hence if such examinations are used as tests for degrees, while they may encourage the cultivation of the knowledge making power in linguistic study, they must discourage and repress it in the study of science.

And if this is the effect of written examinations generally, the effect is of course intensified when they are conducted by a central examining body. For the central examiner, who sets a paper for, say, the schools of a district, can obviously find out even less about the knowledge-making power of candidates than the examiner who can adapt his paper to the work done in a particular school. Centralised examining has serious evil effects of its own. But apart from such effects, which it would be foreign to my subject to discuss now, it must exert a specially strong influence in repressing the cultivation of the knowledge-making power, and in transforming the student into Pope's

"bookful blockhead, ignorantly read,  
With loads of learned lumber in his head."

A third difficulty with which the sound teaching of science has met, arises from the complex character of its subject-matter. To compare different usages of words, for example, one has but to turn over the leaves of a book; to compare instances of the occurrence of natural phenomena, the phenomena must be watched for or reproduced under varying conditions. Knowledge-making, therefore, especially in its early stages, finds more difficult problems in science than in language; and the young investigator meets with greater hindrances to progress. The early investigators felt this difficulty, and banded themselves together in societies in order to enjoy the suggestions and criticism of their fellows. The science student of course needs the helping hand still more; and the teacher must be able to give the requisite aid in a judicious way. He must be a knowledge maker himself, must have sufficient experience in the subject he is teaching, and must be largely endowed with tact and common sense. Unfortunately the old curriculum furnished men with practically no experience of science, the new curriculum furnished men with little knowledge-making power, and no curriculum could furnish the tact and common sense. The available teachers have thus in general been incompetent. And in the making of scientific knowledge, a pupil under an incompetent teacher must stick fast.

Competent teachers in classics, on the other hand, have always been more readily obtainable. And—what is of more importance—in the making of linguistic knowledge, a pupil under an incompetent teacher does not stick fast. He has the experience of his childhood to help him, is capable of exercising the knowledge-making power, without the teacher's aid, on the familiar material which language affords, and in his effort to make progress, cannot help exercising it to a greater or smaller extent. Let me draw special attention to this point; for the fact that in the study of language, exercise of the knowledge-making power is not only possible, but in a large measure inevitable, even under an incompetent teacher, gives to language study a great advantage over science study, as a means of discipline in all educational institutions, but especially in those of lower grade, in which, owing to their large number, the difficulty of securing competent teachers is especially great.

The conclusions we have now reached may be summarised thus:—(1) Few of the subjects of the old curriculum could be studied without exercise of the knowledge-making power;—

many of the subjects of the new curriculum can. (2) The demand for useful information did not affect the old curriculum;—it seriously diminished the exercise of the knowledge-making power in the new. (3) Written examinations might stimulate such exercise in the old curriculum;—they could not but repress it in the new. (4) Competent teachers could readily be secured for the old curriculum;—they have not generally been available for the new. (5) Incompetent teachers could not largely exclude practice in knowledge-making under the old curriculum;—they could not fail to exclude it largely under the new. Obviously, therefore, the more intensely modern the curriculum has become, *i.e.* the more linguistic study has been excluded and science study introduced, the less efficient in general must the curriculum have become, so far as practice in knowledge-making is concerned.

If the above discussion is sound, any system such as our modern system, from which the method of investigation is largely excluded, must be distinctly inferior, as a means of preparing young people for the work of life, to a system such as the one which has become old-fashioned, in which it is given abundant exercise. It is difficult, however, to establish an inferiority in a case of this kind from experience. For in any trial that may be made of the two systems there must always be extraneous circumstances on which the burden of any observed inferiority may be laid. On the present occasion I cannot take time even to summarise such evidence as goes to show that the inferiority which is to be expected has been found to be actual. I must content myself with a mere reference to the result of what is perhaps the most decisive of all the trials which have been made, *viz.*, that made in Prussia as to the relative educational efficiency of the *Gymnasium*, with its largely classical course, and the *Realschule*, with its largely scientific course. Both institutions had been conducted with characteristic German thoroughness with respect to the training of teachers and the provision of equipment, and the written examination system had been applied in a non-centralised form. Except in so far as tradition and the wider privileges of *Gymnasium* graduates may have led the more promising men to enter the *Gymnasium*, the two institutions seem to have worked under equally favourable conditions. Yet when in 1880, after a trial of more than ten years, the question of continuing to admit graduates of the *Realschule* to certain courses of the University of Berlin came up for discussion, even the scientific professors testified that for the work of their departments, mainly scientific research, the men nurtured in the *Gymnasium* had been found better qualified than those who had come up from the *Realschule*. The effect of tradition and privilege may have had much to do with this result; and the means of instruction in science twenty years ago were of course not so elaborate as they are now. But it is significant, that in the light of the present discussion, it was to be expected that for success even in scientific research, *i.e.* the making of new knowledge of natural phenomena, power of knowledge-making, though cultivated on linguistic study only, would be of greater importance than the stock of scientific knowledge which it is the aim of the modern curriculum to afford.

Our own experience in Nova Scotia is less definite. We have not had the two systems running side by side, and can only compare the present state of things with the past; and the comparison is complicated by the fact that the present state of things is in many respects in advance of the past. But there is no doubt that the country is full of a deep and growing discontent, which, though it finds vent at times in ill-grounded criticism, rests in the main on a solid basis. The farmer, to take a single example, finds that the boys he sends to the High School rarely return to the farm. He blames the school, with its Latin and its multiplicity of sciences, and demands the provision of something more practical, such as the teaching of agriculture. There are probably many reasons why the farmer's boy does not return to the farm; but there can be little doubt, if my position is sound, not merely that he is not fitted, but that he is actually unfitted, by his High School course, for the farmer's work. The farmer must, above all things, be able to learn quickly and accurately from his own experience. His boy, after passing through an intensely modern curriculum, under the pressure of a centralised examining system, and under the guidance of teachers in whom, for the most part, the colleges have failed to develop the investigating spirit and power, must almost inevitably be less able to make knowledge for himself out of his own experience, than he would have been, had he

remained on the farm; while even that part of his large stock of acquired knowledge which bears upon agriculture must consist in general of inaccurate and ill-digested epitomes of sciences, in which he has little, if any, genuine interest. The farmer's discontent is therefore probably justified; but he is wrong in the details of his criticism. With the teachers who are at present available, Latin is the subject from which his boy will acquire, more than from any other, the essential power of putting that and that together. Although it is true that the usual synoptic study of the whole circle of the sciences will make his boy neither a farmer nor anything else, it is also true that a more informal study, a knowledge-making as distinguished from a mere information-supplying study, of bodies and the changes they undergo, and of plants and animals, rocks and soils, would cultivate in him the power of using his experience, give him, not much perhaps, but certainly some real knowledge bearing on agriculture, give him the scientific experience requisite for the reading of agricultural books, and give him a living interest in all the operations of the farm. Fruitful teaching in agriculture, however, is impossible. The teacher could teach it only if he were a somewhat experienced farmer himself; and even if he were, he could not teach it adequately to beings with such limited experience as boys.

Nor is the farmer the only exponent of discontent. The feeling of dissatisfaction is general. And if my position is sound it might be expected to be general. For if our school discipline fails to cultivate in our youth the power of learning by experience, it fails to give them what is at least one great essential of success, not in farming merely, but in whatever form of work they may be called upon to undertake.

There is one other educational experience, perhaps specially characteristic of our time, to which I should like to refer, *viz.*, the frequency of the success of the self-made man. His success is usually attributed to innate ability, organising power, push, knowledge of men, and what not. To my mind it is largely due to a well developed power of learning by experience; and he owes that in great measure to the school of practical life in which he has had his training. This school provides an entirely different curriculum from the one we have been considering. It furnishes its pupils with no outfit of information whatever; but compels them to hunt out for themselves such information as they may require. And instead of devising cunning ways of stopping the putting of that and that together, it compels its pupils, by sending them early into active life, to cultivate that power for themselves. Many of them of course go down; for no helping hand is extended to them, and the method is rough. But many manage to obtain the knowledge they require, learn how to put the that and that of their experience together, and graduate, often, as we should say, with high honours, in one or other of the departments of active work. They may not have been brought into contact with much that makes for sweetness and light, and may thus be deficient in literary and general culture; but for all forms of activity that demand the generalising of experience, their rough school has given them a training which is, in some respects at least, admirable. Can we wonder then that the practical man, who rightly regards ability to tackle the main work of life as the most important component of a complete culture, and who sees daily the comparative helplessness of the products of the modern curriculum, decides to send his son as early as possible to the school of practical life?

If, notwithstanding the imperfect manner in which I have presented the value of the knowledge-making power, you are convinced of its great importance, you cannot fail to be interested in the question: How are we to secure its cultivation in the school and college?

We may dismiss at once the proposal suggested by what has been said as to the efficiency of the old-fashioned school, that we should return to the classical curriculum, or, at any rate, to language, as the chief means of educational discipline. Such harking back, even looked at from our present point of view only, would be bad policy, for two reasons, (1) because a combination of language and science study, if both are properly carried out, affords a far better training in knowledge-making than either singly, and (2) because, though an outfit of knowledge of science, adequate for use in the work of life, is no longer capable of being provided beforehand as part of a course of liberal training, the acquisition of power of acquiring knowledge demands considerable scientific experience. A curriculum



of which science is an important component, therefore, should be retained, provided the science as well as the language be studied by knowledge-making methods.

Nor need we stop to consider the assertion, made by eminent educational authorities, that in the school at least, such methods cannot be employed in science, or that they have been tried and have failed. Both assertions are sufficiently met by the fact that under favourable conditions, they have been tried and have succeeded.<sup>1</sup> But it must be admitted that knowledge-making methods could not be introduced generally with success, under the prevalent conditions of the present day. For so long as a large body of varied information is an essential condition of academic distinction, so long as the written examination is used as the main test of proficiency, and so long as teachers themselves have not had the investigating spirit developed in them, the school cannot cultivate the knowledge-making power in any large measure.

Reform, to be radical, therefore, must begin with the universities, and with the leading universities. They only can make the conditions for degrees what they please, and they only can hold the examiner completely in check. The smaller universities and colleges must, in the interests of their students, follow more or less the lead of their bigger sisters; and though Councils of Public Instruction and other bodies which govern schools may be largely free to modify their curricula and to regulate their examinations, they cannot secure the services of teachers who are imbued with the investigating spirit, until that spirit has become embodied in the universities.

But while radical reform may not be possible at present, partial reform can be carried out even by a college such as ours, by its steering a middle course between encouraging the use of knowledge-making methods and supplying the information demanded by the larger universities, and by thus cultivating the power and the spirit of investigation to as great an extent as may be possible under present conditions. And the reform thus inaugurated may be extended to the schools of its district, through the teachers supplied by the college, if the governing body of the schools is willing to co-operate. . . . .

It is true that as the early investigators in science made progress without the complex and therefore costly appliances which the investigator of to-day in general requires, so students can get an astonishingly large amount of practice in knowledge-making with very simple materials, and that consequently a knowledge-making equipment involves much smaller expenditure than that which is required by the up-to-date course. Nevertheless, even for practice in the making of knowledge which was made by others long ago, not to speak of the making of knowledge of a later date, or of new knowledge, our equipment is entirely inadequate.

There is still another aspect in which we are deficient, viz., in the working facilities afforded to professors. That the professor of a scientific subject may cultivate the knowledge-making power in his students, he must be a knowledge-maker himself; and to do so in full measure he must be enabled to prosecute original research under favourable conditions. His work may be humble, and its value may be comparatively small; but provided its value is real, it will help him to kindle in his students the enthusiasm which springs from the conviction that the subject they are studying is a growing subject, and that it is possible for them to assist in its growth. It is not therefore in the interest of the professors, but in the interest of their students, that I hold it to be the duty of the college to give professors both the time and the necessary outfit for research. Giving them the requisite time means the provision of competent assistants. Giving them the requisite outfit means the provision, not necessarily by any means of completely equipped laboratories, but of books and other working appliances sufficient for at least a few lines of research.

At first sight the considerable expenditure which would be required for this purpose, will appear to most of you to be expenditure on luxury; and possibly the benefit which a college derives from the fact that its professors are known as original investigators, although undoubtedly great, may be of the nature of a luxury. But when we reflect on the importance of training all our young people to use their experience, and consequently of stimulating our college students, many of whom are to be the teachers of our youth, to acquire the knowledge-making power in the highest possible degree, it becomes apparent that

research facilities for our professors are not a mere luxury, but are necessary for the performance of thoroughly successful educational work.

I have referred so far only to what liberal training requires. In addition, it is desirable, especially from the point of view of the provision of teachers of higher grade, that those of our students who have shown great promise of power in the making of knowledge, should, without leaving their own country, have ready access to the requisite facilities for research in any department in which they may wish to carry on special study. In other words, Canada ought to have at least one university thoroughly equipped for investigation in all the main departments of knowledge—and I say one, because, however desirable such equipment would be in all, with our local art schools and agricultural schools and other technical schools undeveloped, the country cannot probably afford more than one. And this is desirable, not in order that Canada may take her place worthily among other nations by contributing her share to the growth of knowledge, and not because of the material progress that might result from the advance of science, but mainly because the fruitful investigating work that would be conducted at a fully equipped university, would tend to foster the spirit of investigation in all the colleges, and through the teachers they supply, in all the schools, and would thus tend to make even those who never enter a college better knowledge-makers, and therefore more successful men, in whatever department of work they might be engaged.

It is for this reason that the young people of Canada are to be congratulated, even more than the institution immediately concerned, on the great strides which McGill University has recently been enabled to make towards complete equipment; and for the same reason, I may express the hope, in which I know you will all join, that she may soon acquire as thorough an outfit in all departments as she has already acquired in some. If but one of our universities is to receive complete equipment at present, it is fitting that the one having its seat in our commercial metropolis should be selected for the trust. And if McGill University, regarding herself as the trustee of a rich endowment, held for the benefit of the whole Dominion, is able to rise to the level of her opportunity, her influence will, at no distant date, be felt for good in the life work of every Canadian.

The friends of our smaller colleges must therefore rejoice in the rapid enrichment of their more fortunate sister. Nevertheless its first effect upon them has naturally been one of depression. It is obviously impossible for them to do for the colleges in which they are interested, what McGill's benefactors are doing for her. And, although in a country of such magnificent distances as Canada, it is obviously desirable that our young men should have colleges, or at least a college, provided for them in their own section of the Dominion, in order that as many of them as possible may enjoy the advantage of the higher forms of education, and also that their own section may retain their services for its own development, those who have hitherto supported the smaller colleges naturally ask: Is it worth while for us to make any further effort? Indeed, are we justified in encouraging our young people to attend the smaller colleges when a university so much more fully equipped is open to them?

Such questions receive their answer from the present discussion. Liberal training does not demand, as the provision of encyclopædic knowledge does, that students should be supplied with all the books and all the latest contrivances in all departments of knowledge, or even in any department. It demands only, so far as subjects requiring costly equipment are concerned, that they should have access to such equipment in the chief departments as will enable them to have sufficient and sufficiently varied exercise of the knowledge-making power. Complete equipment is requisite only in an institution which aims at furnishing opportunity for original research on all lines, in fact, at the making of specialists rather than the making of men. Only a small part of such an equipment is necessary for, or can be used in, even the most thorough liberal training.

It follows that the small college with incomplete equipment can furnish quite as sound and thorough liberal training as the completely equipped university, provided it is not too small to supply the important training which college life affords, and provided its equipment, though comparatively small, is adequate; and consequently, that if both these conditions are fulfilled, it is completely justified in inviting students to trust their training to its care.

<sup>1</sup> See Armstrong: "The Heuristic Method of Teaching: Special Reports on Educational Subjects," vol. ii. (London: Education Department, 1898.)